

PSS 4000 Safety Gate with PSENslock Instruction List



Product

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Name: PSS 4000, Blocks, PAS4000, PLC, IL
Manufacturer: Pilz GmbH & Co. KG, Safe Automation

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April 2012

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Abbreviations

PAS	P ilz A utomation S uite (software platform)
PSS	Programmable control system (DE: P rogrammierbares S teuerungssystem)
PNOZ	Pilz E-STOP Positive-guided (DE: P ilz N OT-AUS-Zwangsgeführt)
POU	P rogram O rganisation U nit
PRG	P rogram
FB	F unction B lock
FUN	F unction
IL	Instruction L ist

1. Useful documentation

Reading the documentation listed below is necessary for understanding this application note. The availability of the indicated tools and safe handling are also presupposed with the user.

1.1. Documentation from Pilz GmbH & Co. KG

No.	Description	Item No.
1	Pilz international homepage, download section	www.pilz.com
2	Operating Manual PSSu H PLC1 FS SN SD	21939-EN-xx
3	Operating Manual PSSu E F 4DI	21 311-xx
4	Operating Manual PSSu E F DI OZ 2	21 329-xx
5	Operating Manual PSSu E F 4DO 0.5	21 317-xx
6	Bedienungsanleitung PSSu E S 4DI	21 340-EN-xx
7	Bedienungsanleitung PSSu E S 4DO 0.5	21 346-EN-xx
8	Operating Manual PSSu E PD	21 305-xx
9	System Description Programmable safety and control system PSS 4000	1001 467-EN-xx
10	Safety Manual Programmable safety and control system PSS 4000	1001 468-EN-xx
11	PAS4000 online help	-
12	Operating Manual PSEN sl-1.0p 2.1	21 910_xx

1.2. Documentation from other sources of information

No.	Description	Item No.
1		
2		

Note

The present example (PSS 4000 Safety Gate with PSEnSlock) is also available in the programming languages [Structured text](#) and [PASmulti](#).

2. Hardware configuration

2.1. Pilz products

No.	Description	Order number	Version	Number
1	PSSu H PLC1 FS SN SD	312 070	001	1
2	PSSu E F 4DI	312 200	-	1
3	PSSu E F DI OZ 2	312 220	-	1
4	PSSu E F 4DO 0.5	312 210	-	2
5	PSSu E S 4DI	312 400	-	1
6	PSSu E S 4DO 0.5	312 405	-	1
7	PSSu E PD	312 195	-	1
8	PSSu BP 1/8 C	312 601	-	7
9	PSEN sl-1.0p 2.1	570 601	-	1
10	PAS4000	-	v1.5.0	1

2.2. Hardware configuration

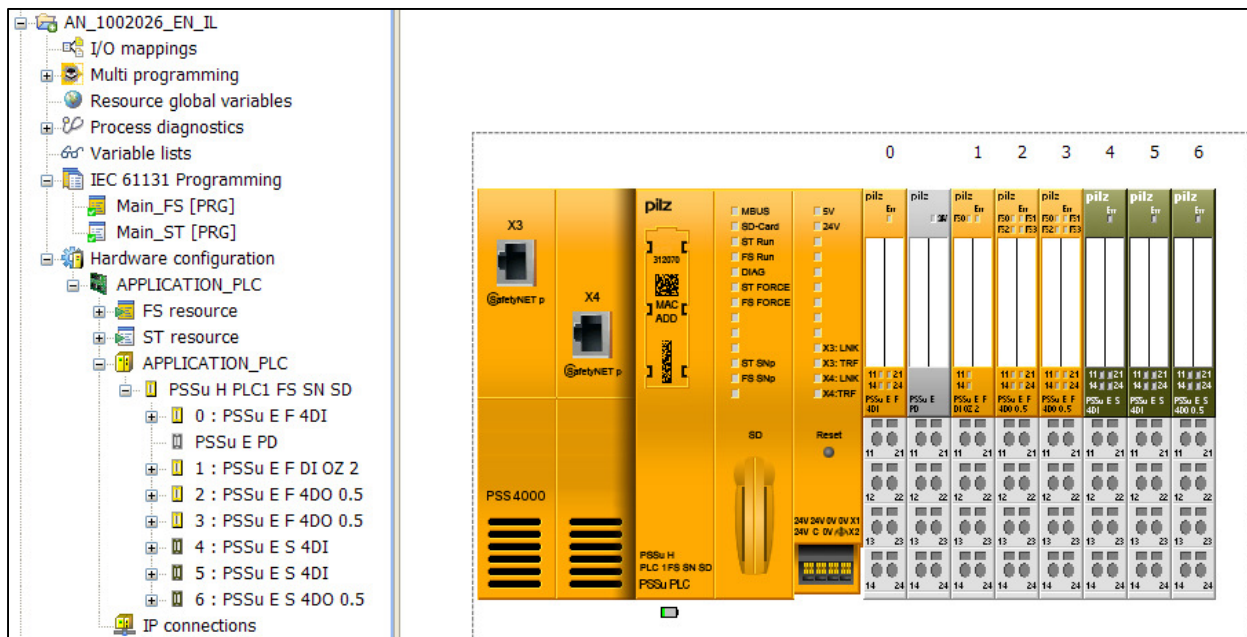


Fig. 1: Hardware configuration

3. Application Task

3.1. Description

The example shows the implementation of a safety gate application with a PSS 4000 PLC. The safe control and evaluation of the signals is taken over by two Pilz Function blocks (FS-FB) from the library.

- ▶ FS_SafetyGate
CRC ADDB

- ▶ FS_OutputFBL
CRC B3A7

The workflow is divided into the following two main functions:

- ▶ Safety Gate and
- ▶ Feedback Loop Monitoring

3.1.1. Safety gate monitoring function

The control system monitors the safety gate switch (S1) via the user program. An instance of the Pilz function block “FS_SafetyGate” is assigned to them. This FS-FB detects whether the assigned safety gate switch has been operated, as well as detecting incorrect input signals and whether the contact synchronization time has been exceeded, etc.

If the safety gate switch are operated or an error occurs, the enable output “Enable” on the FS-FB will immediately be reset.

The enable output “Enable” is also reset when the PSS is stopped and when the PSS is switched on. The signal from the enable output “Enable” must be evaluated by the user program and trigger an appropriate reaction.

Based on the diagnostic outputs (“DiagSwitchError”, “DiagInputNotValid”) it can be determined why “Enable” was reset.

The outputs “DiagOperated”, “DiagReadyForReset” and “DiagReadyForTest” are used as status messages.

A “valid bit” is formed by the system for the respective hardware input to determine whether a process value received from a sensor is valid.

The valid bit is queried in the Function block and indicates whether an error has occurred in the signal transmission between hardware input and processor (such as test clock error, module overheats, etc.).

If the valid bit is FALSE, the process value is invalid and the Pilz function block provides an appropriate diagnostic message. The error signal reset enable.

(For more information, see “Validity process data” in PAS4000 online help)

The way in which the error is reset will depend on the operating mode set on the FS-FB. In this application example, parameters for FS-FB have been set in such a way that “Reset” (S3) is required in order to reset output parameter “Enable” when:

- the PSS is cold started (PSS switched from off to on),
- warm started (PSS transferring from STOP to RUN) or
- when the safety gate switches are released.

Although the safety gate functions are configured to reset themselves, a PSS cold start or the closing of the safety gate may not directly enable a machine to start up without further conditions being met.

Input circuit safety assessment

- ▶ A short between the input circuits within a multicore cable will be detected as an error by the PSEnSlock.
- ▶ A short between 24 VDC and an input circuit will be detected as an error by the PSEnSlock.
- ▶ If the shutdown occurs via the inputs of the PSEnSlock, reactivation of the outputs is only possible after both safety inputs have been locked simultaneously (partial operation lock).
- ▶ If an operator completely (or even maybe partly) is able to access the dangerous area, a risk analysis should clarify whether an additional, separate “manual reset function” is required.

Caution:

The magnetic guard locking of the PSEnSlock is only for process protection, but not as a safety guard locking (personal protection).

3.1.2. Feedback loop monitoring function

The control system monitors the feedback circuits (NC contacts) of the motor contactors KM1 and KM2 via the user program.

An instance of the Pilz function block “FS_OutputFBL” is assigned to them.

The FS_FB drives the contactors as well as monitoring the feedback loop.

A 1-signal at input parameter “Input” of the FS-FB sets the outputs that drive the contactors, “Output1” and “Output2”, to “1”; a 0-signal sets it to “0”.

If an error occurs, the outputs “Output1” and “Output2” that drive the contactors on FS-FB will immediately be reset. Both outputs are also reset when the PSS is stopped and when the PSS is switched on.

Based on the diagnostic outputs (“DiagFeedbackLoopError”, “DiagFeedbackLoopNotValid”) it can be determined why the outputs were reset.

A “valid bit” is formed by the system for the respective hardware input to determine whether a process value received from a sensor is valid.

The valid bit is queried in the Function block and indicates whether an error has occurred in the signal transmission between hardware input and processor (such as test clock error, module overheats, etc.).

If the valid bit is FALSE, the process value is invalid and the Pilz function block provides an appropriate diagnostic message. The error signal reset enable.

(For more information, see “Validity process data” in PAS4000 online help)

If an error occurs, a new activity has to take place at the input “Input” of the FS-FB once the error has been rectified, so that the outputs “Output1” and “Output2” will be set again.

Feedback loop monitoring safety assessment

- ▶ A short between 24 VDC and a safety output or a feedback loop input will be detected as an error by the programmable safety system. The load can be switched off via the second shutdown route.
- ▶ The feedback loop contacts must be installed in a single mounting area (control cabinet).
- ▶ To achieve a higher level of safety, 2 actuators must be used.

3.2. Functional safety

3.2.1. Safety-related characteristics in accordance with EN ISO 13849-1

No.	Safety function	PL	Safety-related parts of the control system
1	Machine shut down when a safety gate is opened	PL e	Sensor (PSEN sl-1.0p 2.1 S1) Input (PSSu E F 4DI) Logic (PSSu H PLC1 FS SN) Output (PSSu E F DI OZ 2) Actuator (contactors KM1, KM2)

Prerequisites

No.	Description	Identification	
1	Common cause failure (CCF)	Requirements are considered to be met (must be tested on implementation)	
2	Mission time	20 years	
3	Operating interval (electromechanical components)	Sensor	two operations per hour
		Actuator	two operations per hour
4	Characteristic data of contactors KM1/KM2	B10d	2,000,000

Please note the further requirements of EN ISO 13849-1, e.g. requirements for avoiding systematic faults.

3.2.2. Safety-related characteristics in accordance with EN 62061

No.	Safety-related control function (SFCF)	Safety Integrity Level	Subsystems
1	Machine shut down when a safety gate is opened	SIL 3	Sensor (PSEN sl-1.0p 2.1 S1) Input (PSSu E F 4DI) Logic (PSSu H PLC1 FS SN) Output (PSSu E F DI OZ 2) Actuator (contactors KM1, KM2)

Prerequisites

No.	Description	Identification	
1	Common cause failure (CCF)	$\beta = 2\%$ (must be tested on implementation)	
2	Proof test interval	20 years	
3	Operating interval (electromechanical components)	Sensor	two operations per hour
		Actuator	two operations per hour
4	Characteristic data of contactors KM1/KM2	B10d	2,000,000
		Dangerous failure rate	65%

Please note the further requirements of EN 62061, e.g. requirements for systematic safety integrity.

3.3. PAS-Project

To operate a plant with one or more programmable control systems PSS 4000, a project must be created in PAS4000.

A project consists of the hardware configuration and the user program.

3.3.1. IEC 61131 Programming

When programming in accordance with IEC 61131, the user program is structured by three types of program organisation units (POUs):

- ▶ Programs (PRG)
- ▶ Function blocks (FB)
- ▶ Functions (FUN)

The program forms the higher structural level. Functions and function blocks may be called up within a program.

Function blocks and functions undertake specific individual tasks within the program.

Each POU consists of a declaration part and an instruction part.

The variables and type declarations are made in the declaration part, which is shown in text format, irrespective of the programming language.

The instruction part contains the instructions. The instructions can be formulated in one of the IEC 61131 programming languages.

(For more information about programming with PAS4000, look at PAS4000 online help)

3.3.1.1. IL-Editor

The program for the cyclic process is created in a POU of the type “Program”.
The Pilz function blocks for safety gate and feedback loop were added from the library. (Right-click in the declaration part of the POU “Add library element”)

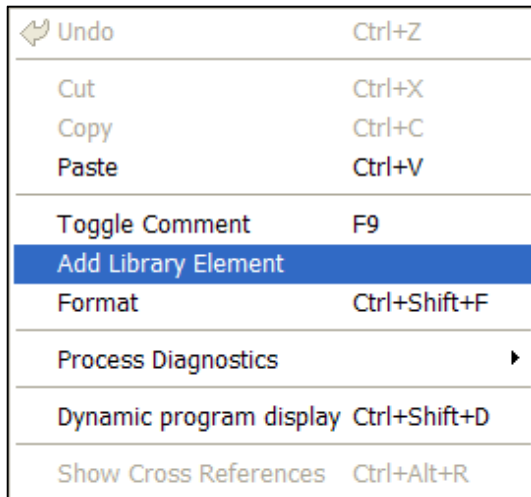


Fig. 2: Add library element

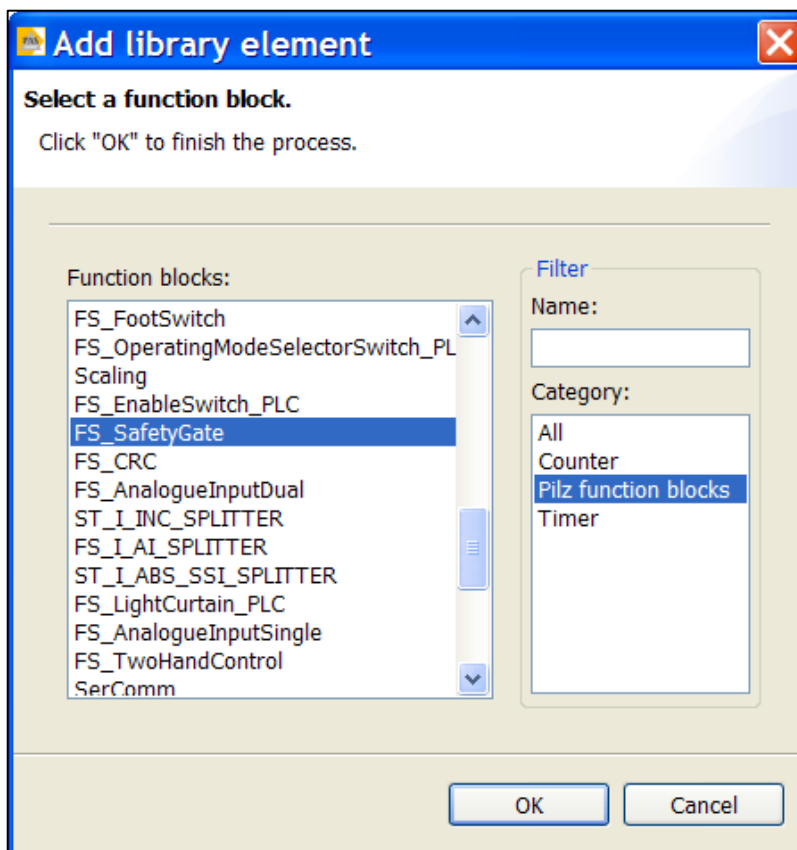


Fig. 3: Selection library element

Failsafe program

Declaration part

```
001 PROGRAM Main_FS
002 VAR
003     // My SGATE 1
004     MySafetyGatel                               : FS_SafetyGate;
005     MySGatel_Enable                             AT %Q* : SAFEBOOL;
006     MySGatel_DiagOperated                       AT %Q* : SAFEBOOL;
007     MySGatel_DiagReadyForReset                 AT %Q* : SAFEBOOL;
008     MySGatel_DiagReadyForTest                   AT %Q* : SAFEBOOL;
009     MySGatel_DiagSwitchError                   AT %Q* : SAFEBOOL;
010     MySGatel_DiagInputNotValid                 AT %Q* : SAFEBOOL;
011
012     // My FBL
013     MyFeedBackLoop1                             : FS_OutputFBL;
014     MyFBL1_DiagFBL_Error                         AT %Q* : SAFEBOOL;
015     MyFBL1_DiagFBL_NotValid                     AT %Q* : SAFEBOOL;
016 END_VAR
017
018 VAR CONSTANT
019     // Declaration SwitchType 3 (NCNC)
020     MySGATE1_DOUBLE_CH                           : USINT := USINT#3;
021 END_VAR
```

Instruction part

```
022     // Safety-Block Light Curtain 1
023     CAL MySafetyGatel (
024         SwitchType := MySGATE1_DOUBLE_CH,
025         AutoStart := FALSE,
026         AutoReset := FALSE,
027         MonitoredReset := TRUE,
028         StartupTest := FALSE,
029         SimultaneityTime := T#100ms,
030         DelayTime := T#40ms,
031         Enable => MySGatel_Enable,
032         DiagOperated => MySGatel_DiagOperated,
033         DiagReadyForReset => MySGatel_DiagReadyForReset,
034         DiagReadyForTest => MySGatel_DiagReadyForTest,
035         DiagSwitchError => MySGatel_DiagSwitchError,
036         DiagInputNotValid => MySGatel_DiagInputNotValid
037     )
038
039     // Safety-Block monitoring FBL1 and release motor1
040     CAL MyFeedBackLoop1 (
041         Input := MySGatel_Enable,
042         FeedbackLoopTime := T#200ms,
043         DiagFeedbackLoop_Error => MyFBL1_DiagFbl_Error,
044         DiagFeedbackLoop_NotValid => MyFBL1_DiagFbl_NotValid
045     )
046
047     END_PROGRAM
```

Standard program

The signals from the start- and stop switch and those the control switch for the magnetic guard locking are imported from standard modules PSSu E S 4DI (1A4, 1A5). These signals belong to the standard control functions of the machine.

The program code for the evaluation and processing of these signals is not processed within the FS resource (safety-related part) of the control, but in a ST resource in a separate task as independent application (additional POU of type program).

Declaration part

```
001 PROGRAM Main_ST
002 VAR
003     // Start / Stop
004     MyRisingEdge1                : R_TRIG;
005     Start                        AT %I* : BOOL;
006     Stop                         AT %I* : BOOL;
007     Start_FLR                   : BOOL;
008     Set_Motor1                  : BOOL;
009     Reset_Motor1                : BOOL;
010     Motor1_On                   AT %Q* : BOOL;
011     Other_Stop_Conditions       AT %I* : BOOL;
012     FF_Motor1On                 : RS;
013
014     // Lock SGate1
015     MyRisingEdge2                : R_TRIG;
016     MySGate1_Lock                AT %I* : BOOL;
017     MySGate1_Unlock              AT %I* : BOOL;
018     MySGate1_SignalOutputLock    AT %I* : BOOL;
019     MySGate1_LockUnlock          AT %Q* : BOOL;
020     MySGate1_Lock_FLR           : BOOL;
021     MySGate1_Request_Unlock      : BOOL;
022 END_VAR
```

Instruction part

```
023     //--- Motor -----
024
025     // Rising Edge 1 - Monitoring Start
026     CAL MyRisingEdge1(
027     clk := Start,
028     q => Start_FLR
029     )
030
031     // Start Motor1
032     LD Start_FLR
033     // AND Other_Start_Conditions // e.g. Operating Mode
034     ST Set_Motor1
035
036     // Stop Motor1
037     LDN Stop
038     ORN Other_Stop_Conditions // e.g. Enable Signal SGate1
039     ST Reset_Motor1
040
041     // Flip-Flop Motor1 On
042     CAL FF_Motor1On(
043     set := Set_Motor1,
044     reset1 := Reset_Motor1,
045     q1 => Motor1_On
046     )
047
```



```
048      //--- LOCK -----
049
050      // Rising Edge 2 - Monitoring Lock
051      CAL   MyRisingEdge2 (
052      clk := MySGate1_Lock,
053      q => MySGate1_Lock_FLR
054      )
055
056      // Close Magnetic Guard Locking Device "Lock"
057      LD    MySGate1_Lock_FLR
058      AND   MySGate1_SignalOutputLock
059      S     MySGate1_LockUnlock
060
061      // Request "Unlock" In Process
062      LDN   MySGate1_Unlock
063      S     MySGate1_Request_Unlock
064
065      // Open Magnetic Guard Locking Device "Unlock"
066      LD    MySGate1_Request_Unlock
067  // AND   Other_Lock_Conditions (e.g. Machine Standstill)
068      R     MySGate1_LockUnlock
069      R     MySGate1_Request_Unlock
070
071      END_PROGRAM
```

3.3.2. I/O Mapping

In PAS4000, variables can be created and the user program can be programmed without the need of the mapping to the hardware being present at the beginning of the project.

After identification of the used I/O from the variable declaration, the required hardware can be determined.

The I/O mapping editor forms the connecting between the user program and the hardware and coordinates the available I/O and existing PI-variables.

3.3.2.1. I/O Mapping Editor

The PI variables declared in the user-program can be assigned in the I/O mapping editor to the hardware configuration.

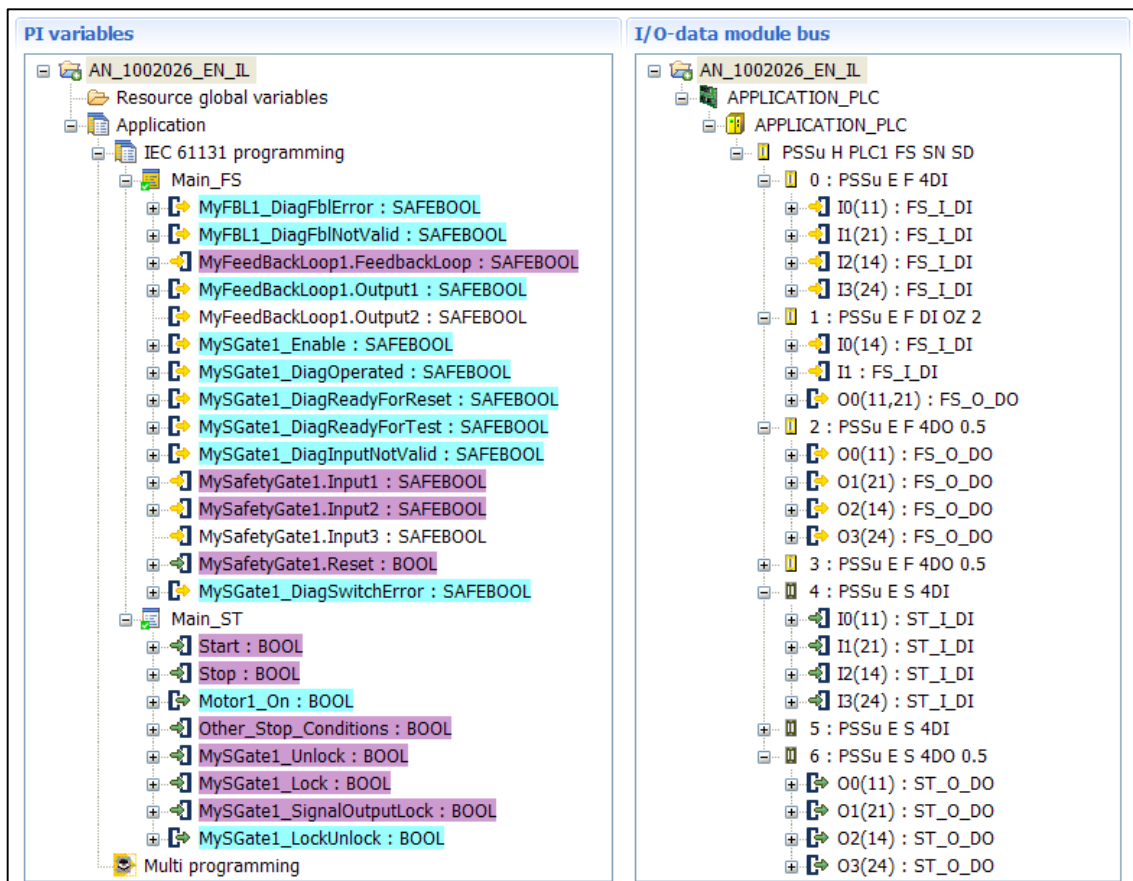


Fig. 4: Mapping Editor – IL-program

3.3.3. Process PAS Project

- ▶ Step 1: In the IL editor, PI variables and the logical sequence will be generated as a program.

```
PROGRAM Main_FS
VAR
  MySGate1_DiagInputNotValid AT %Q* : SAFEBOOL;
  MyFBL1_DiagFblError        AT %Q* : SAFEBOOL;
```

Fig. 5: PI variables

- ▶ Step 2: The design of the hardware (control, I/O, sensor, actor) will be created as a circuit diagram. (parallel possible to Step 1)

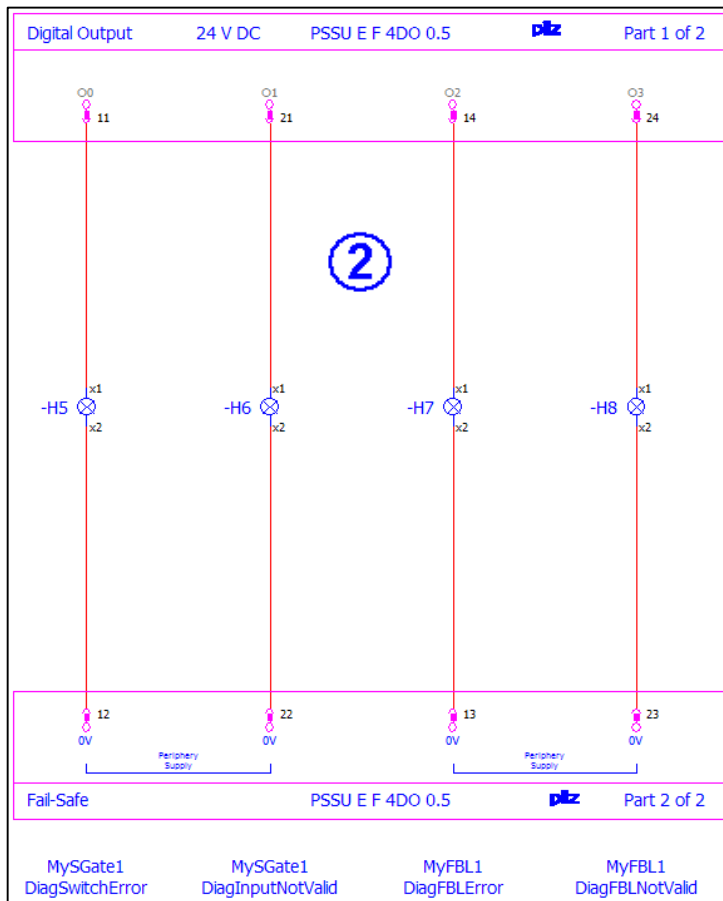


Fig. 6: Circuit diagram (extract)

- ▶ Step 3: Based on the PI variables (I/O), the required power of control (PLC, Multi) is selected. The implementation of the I/O modules in the PAS system occurs in the PSSu module editor.

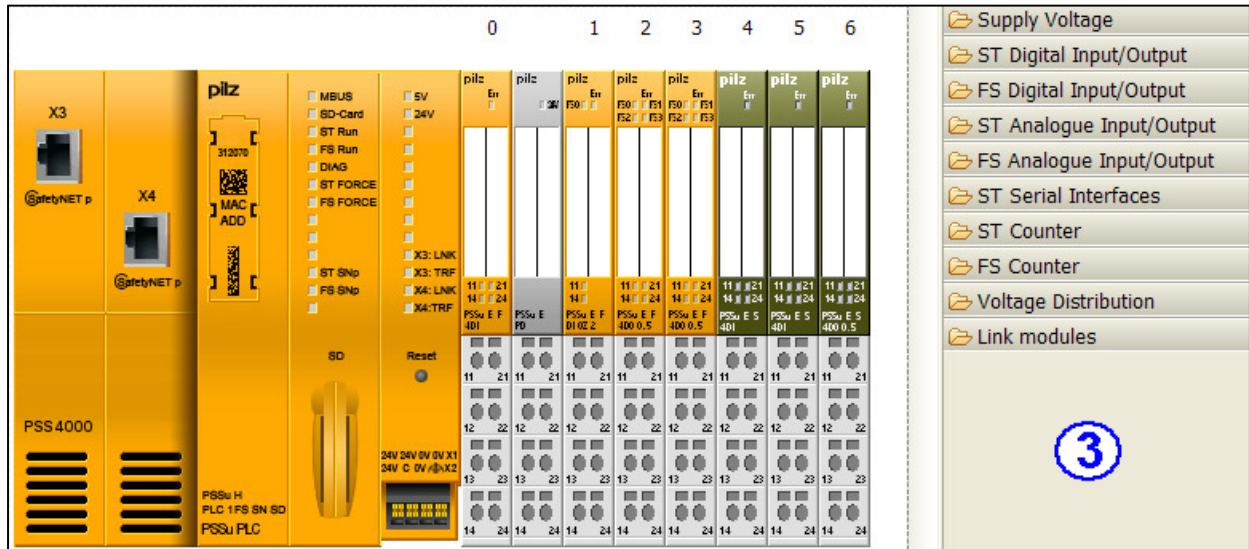


Fig. 7: PSSu Module Editor

- ▶ Step 4: Assignment of the PI variables in the I/O Mapping Editor.

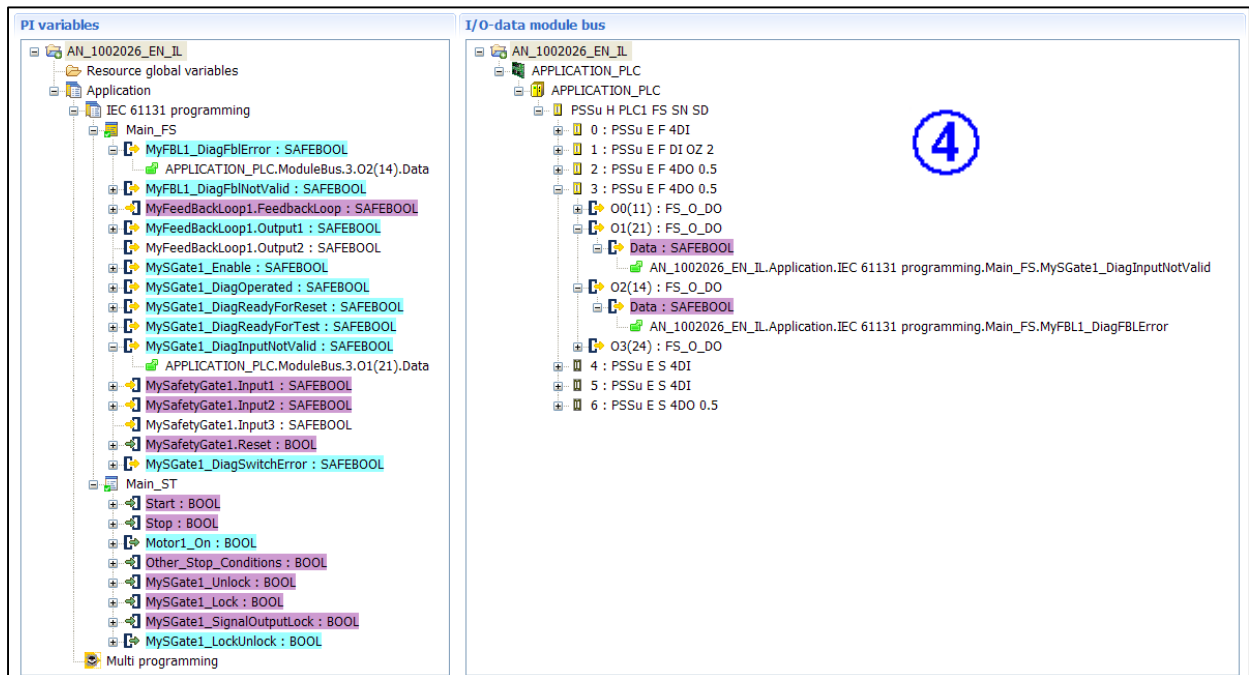


Fig. 8: I/O Mapping Editor

► Overview process PAS Project (Steps 1-4)

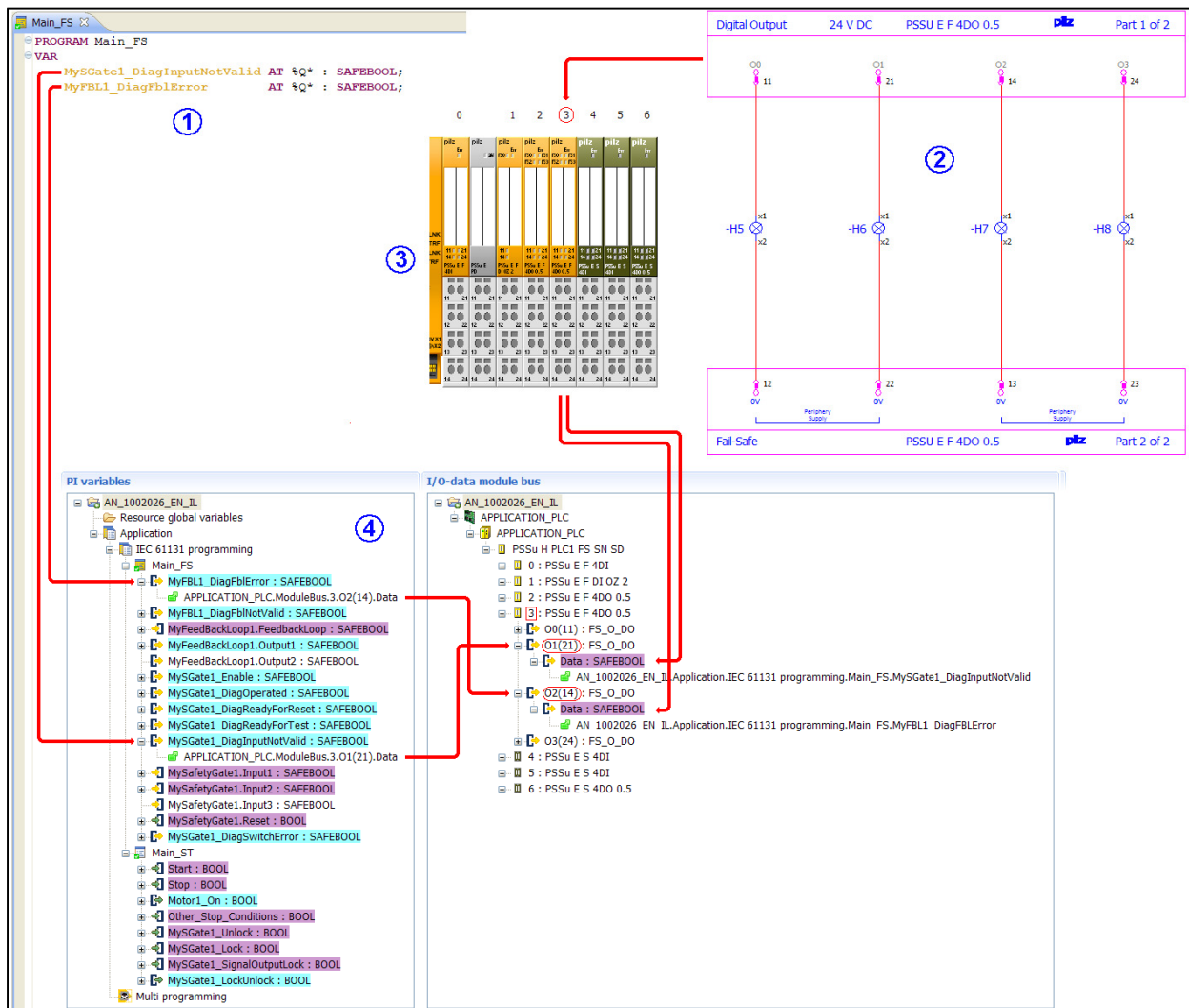
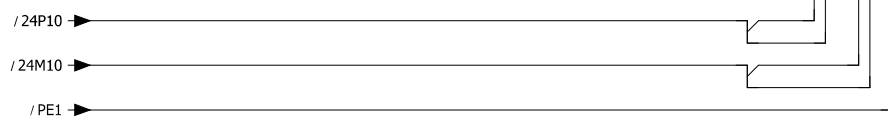
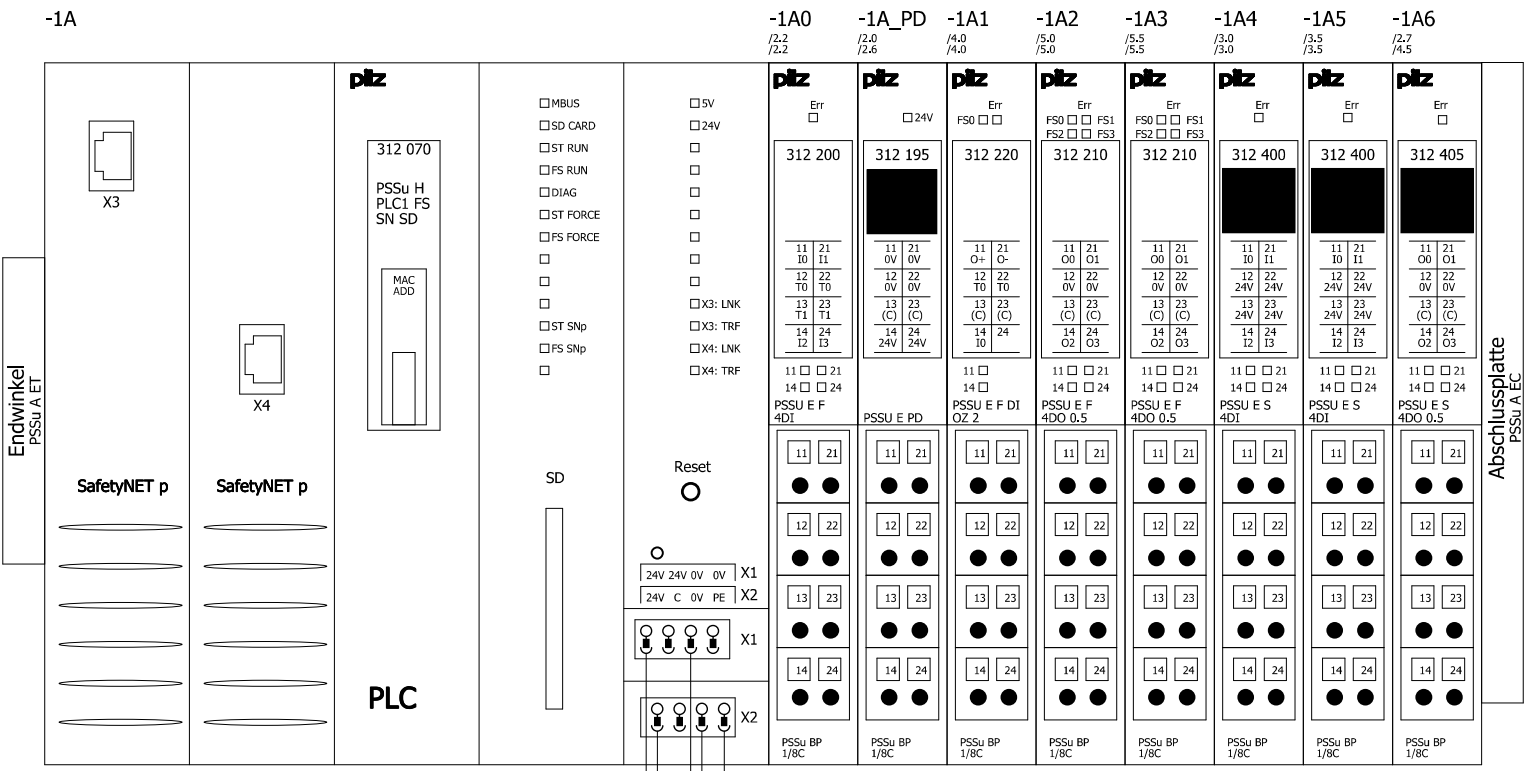


Fig. 9: Process PAS Project



- PSSu E PD 312 195
- PSSu E F 4DI 312 200
- PSSu E F DI OZ 2 312 220
- PSSu BP 1/8C 312 601
- PSSu E F 4DO 0.5 312 210
- PSSu BP 1/8C 312 601
- PSSu E F 4DO 0.5 312 210
- PSSu BP 1/8C 312 601
- PSSu E S 4DI 0.5 312 400
- PSSu BP 1/8C 312 601
- PSSu E S 4DO 0.5 312 405
- PSSu BP 1/8C 312 601

Revision	08.03.2012	Date	19.01.2005
Name	RDS	Name	RDS
		Dep.	CS

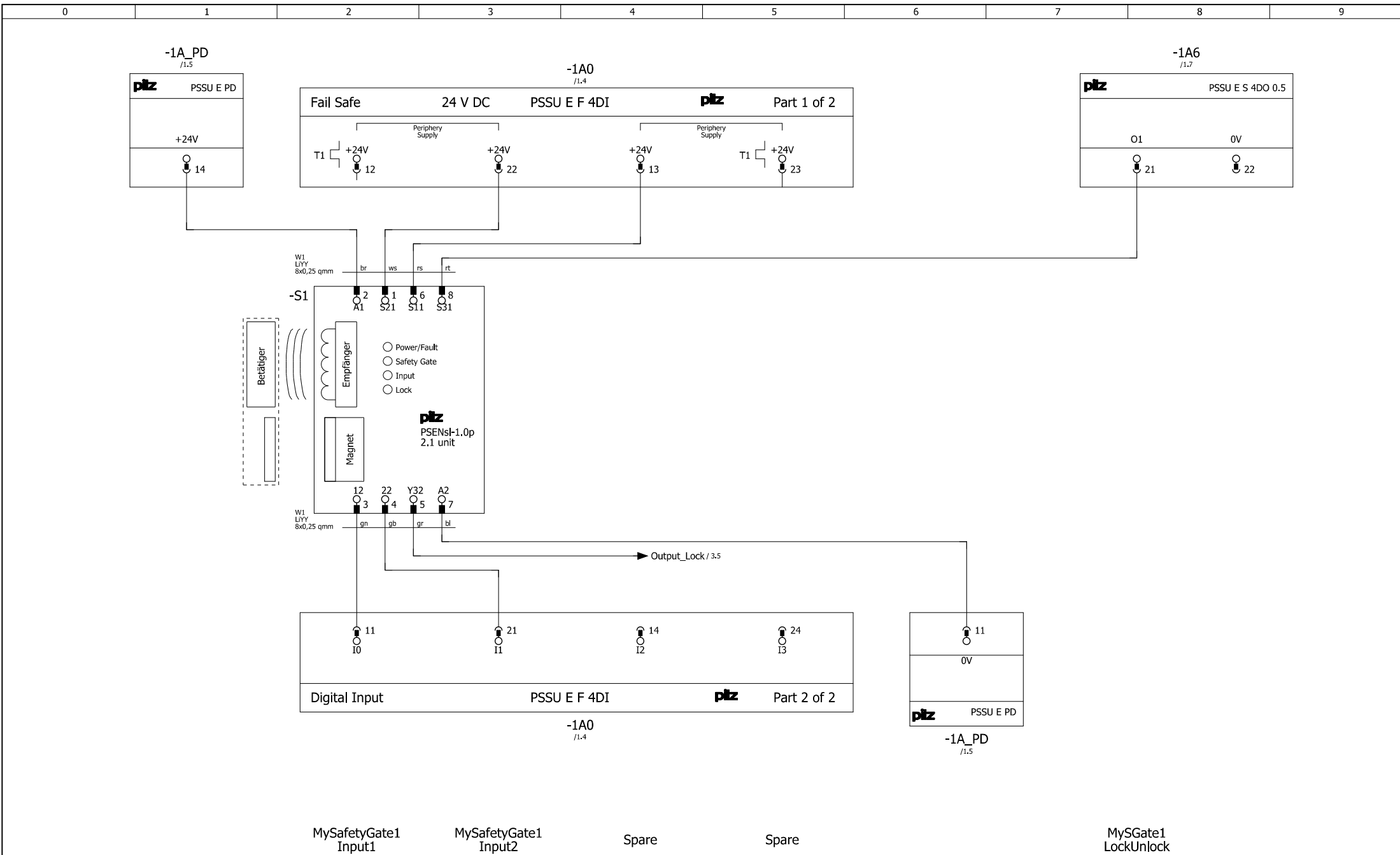
EN ISO 13849-1:2006 PL e
 EN 62061:2005 SIL 3



PSS 4000 - Safety Gate with PSENSlock
 Power supply PSS 4000

Mounting place
 + AN_1002026_02

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Revision	08.03.2012	Date	19.01.2005
Name	RDS	Name	RDS
		Dep.	CS

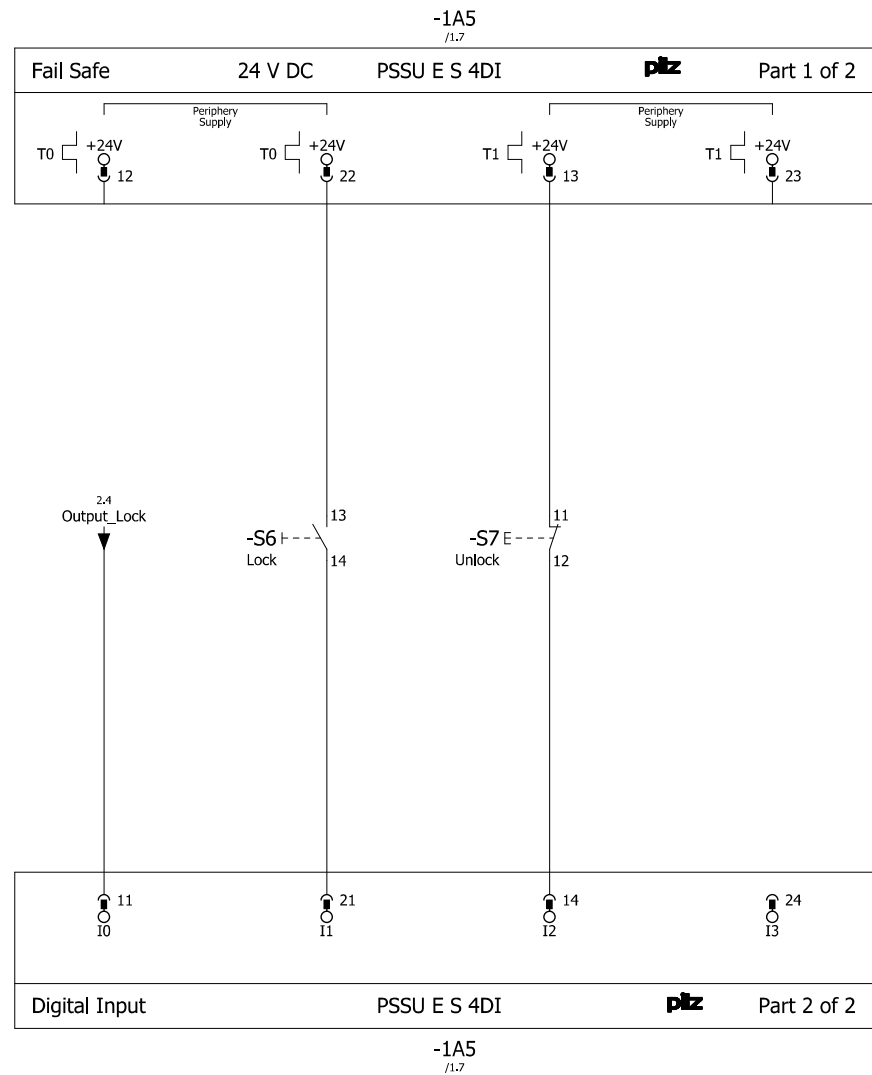
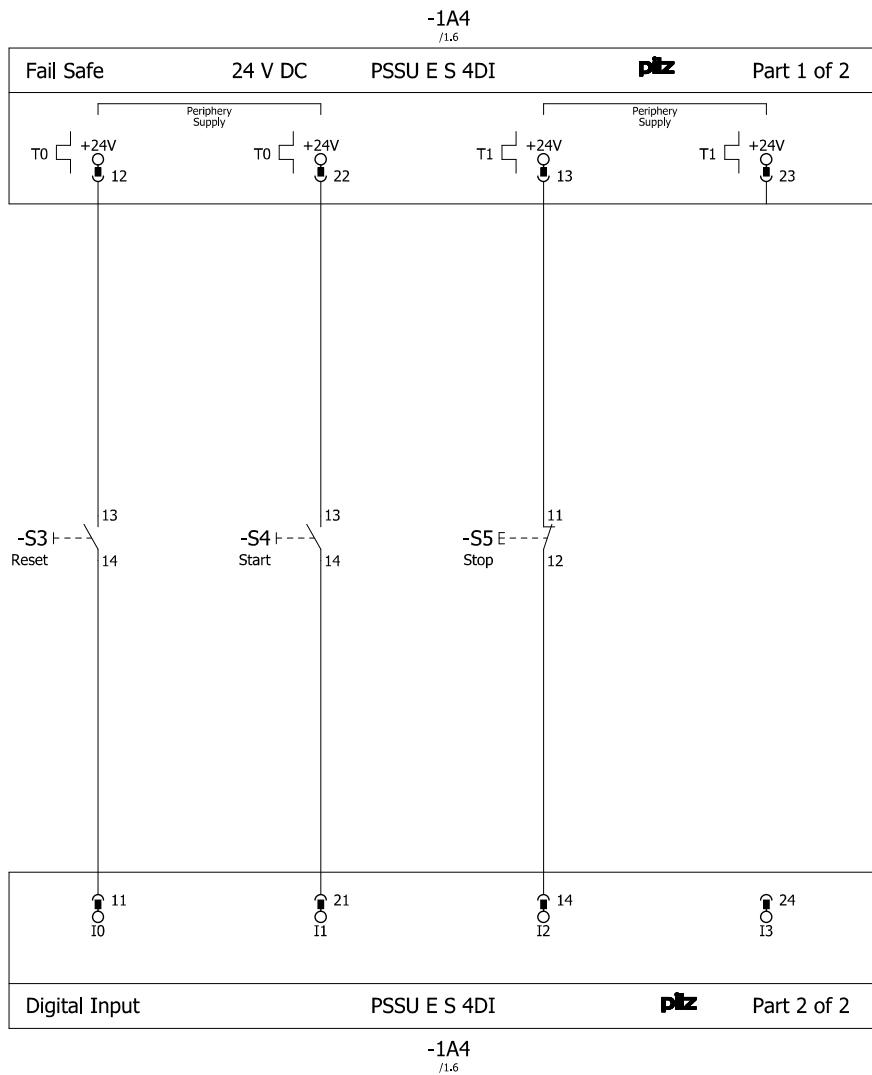
EN ISO 13849-1:2006	PL e
EN 62061:2005	SIL 3

pilz Pilz GmbH & Co. KG
 Felix-Wankel-Str. 2
 73760 Ostfildern

PSS 4000 - Safety Gate with PSENslock
 Inputs

Mounting place
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MySafetyGate1
Reset Start Stop Spare

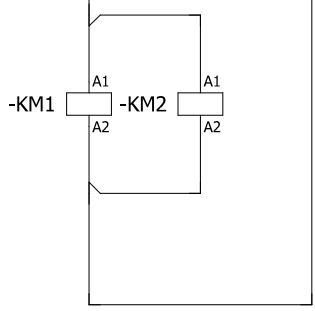
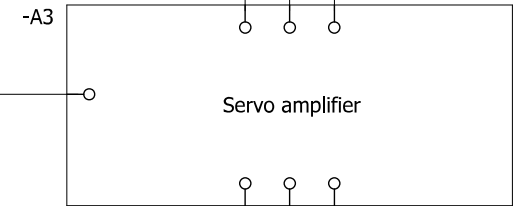
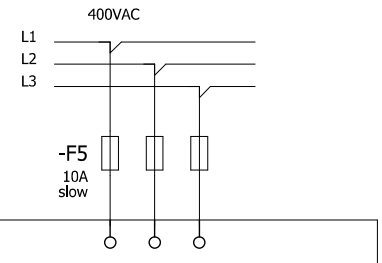
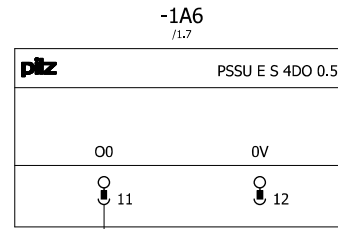
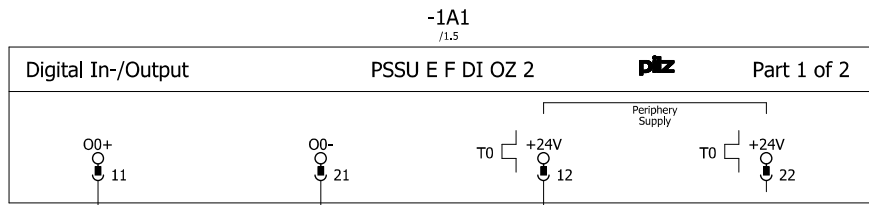
MySGate1
Signal Output Lock MySGate1
Lock MySGate1
Unlock Spare

Revision	08.03.2012	Date	19.01.2005
Name	RDS	Name	RDS
		Dep.	CS

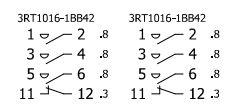
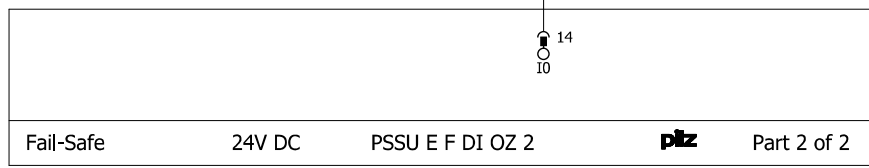
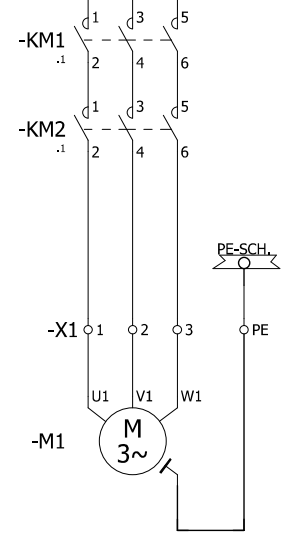
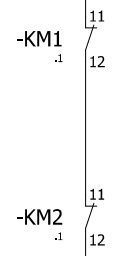
EN ISO 13849-1:2006 PL e
EN 62061:2005 SIL 3



PSS 4000 - Safety Gate with PSENSlock
Inputs 2

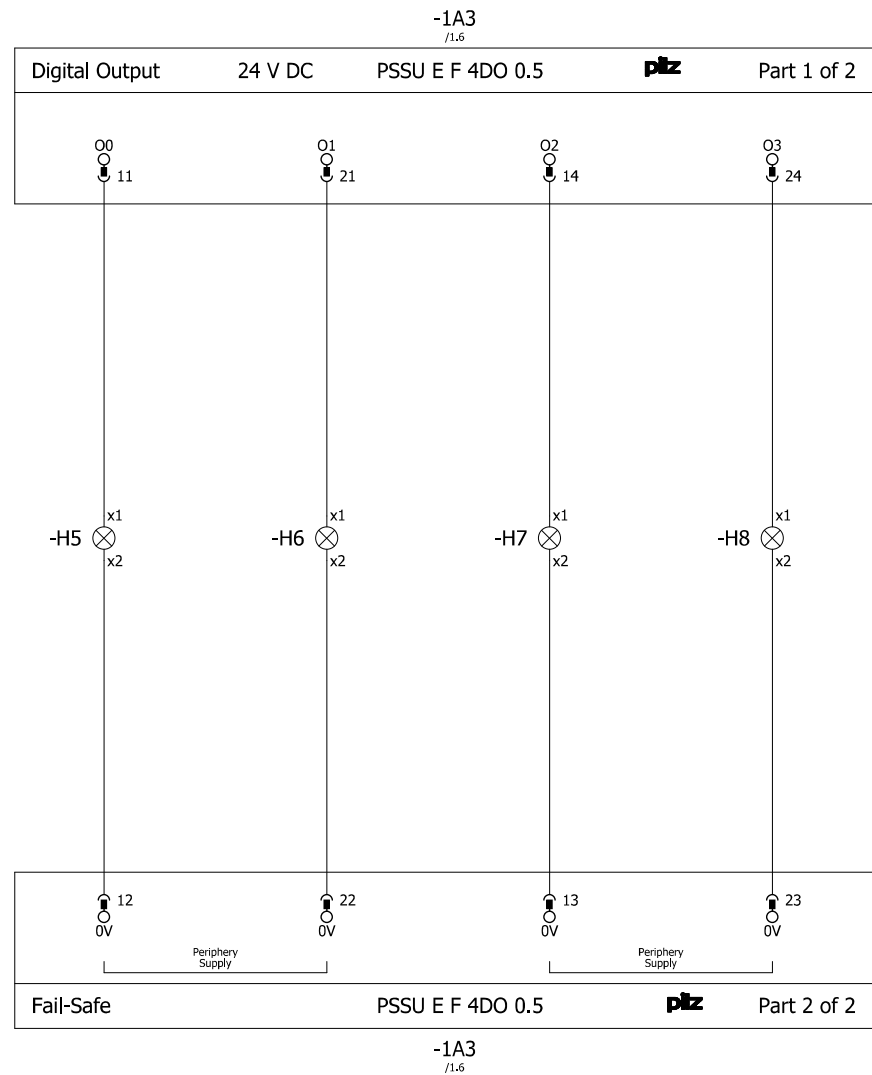
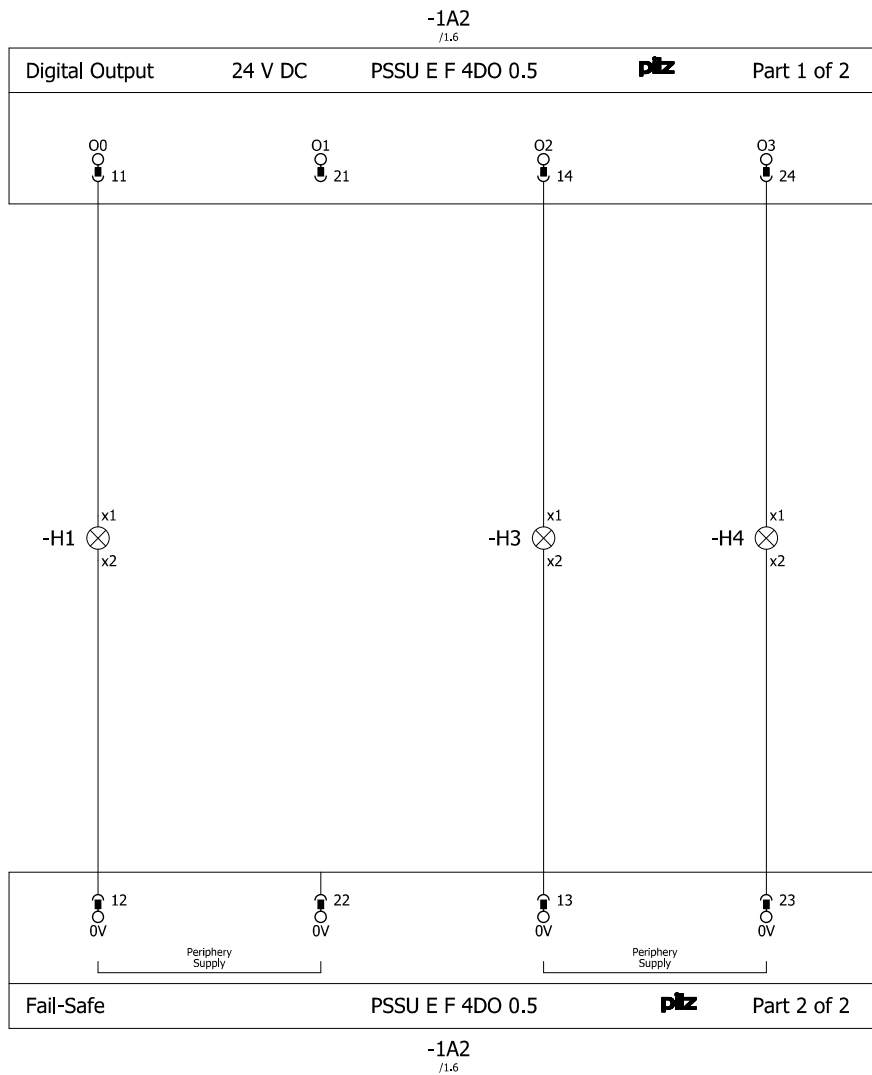


MyFeedBackLoop1
Output1



MyFeedBackLoop1
FeedbackLoop

Motor1_On



MySGate1
DiagOperated

Spare

MySGate1
DiagReadyForReset

MySGate1
DiagReadyForTest

MySGate1
DiagSwitchError

MySGate1
DiagInputNotValid

MyFBL1
DiagFBLError

MyFBL1
DiagFBLNotValid

Revision	08.03.2012	Date	19.01.2005
Name	RDS	Name	RDS
Dep.		Dep.	CS

EN ISO 13849-1:2006 PL e
EN 62061:2005 SIL 3



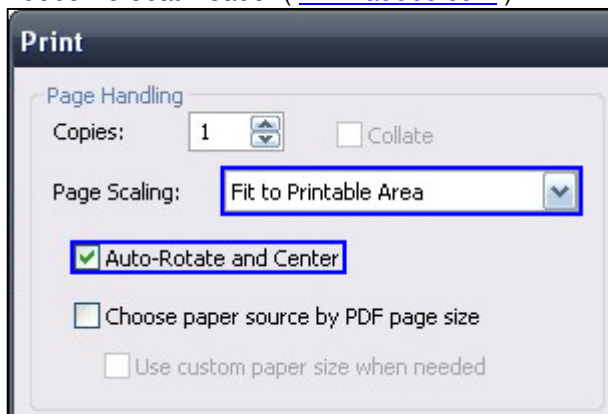
PSS 4000 - Safety Gate with PSENSlock
Status/Error message

4. Table of figures

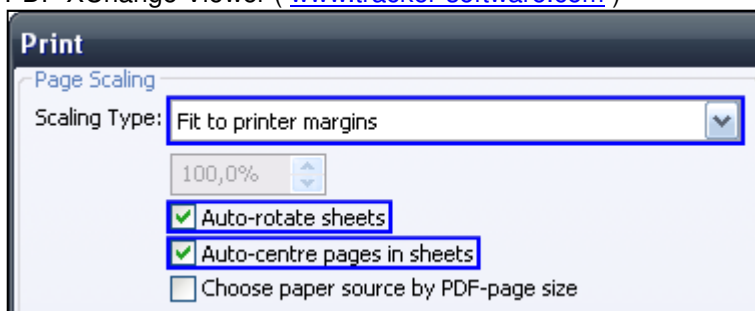
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Recommended printer settings

Adobe Acrobat Reader (www.adobe.com)



PDF-XChange Viewer (www.tracker-software.com)





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